CLAIMS

~~What is claimed is:~~

1. A sensor system for determining occupancy in a space, comprising:

a transmitter radio device that transmits radio signals over a channel in the space;

a receiver radio device that receives the transmitted radio signals that have traveled through the space; and

at least one processor implementing an occupancy-centric algorithm that determines occupancy in the space based on the radio signals, wherein the at least one processor:

determines channel state information based on the radio signals transmitted over the channel,

determines occupancy in the space based on the channel state information, and

outputs an occupancy signal based on the determined occupancy.

2. The sensor system of claim 1, wherein the at least one processor is:

integrated with the receiver radio device~~.~~, or

~~3. The sensor system of claim 1, wherein the at least one processor is~~

integrated with the transmitter radio device.

~~4.~~3. The sensor system of claim 1, further comprising a computing device, wherein the at least one processor is integrated with the computing device.

~~5.~~4. The sensor system of claim 1, wherein the at least one processor outputs a control signal to a control system.

~~6.~~5. The sensor system of claim ~~5~~ 4, wherein the control system is associated with at least one of:

a heating, ventilating, and cooling system for the space~~.~~,

~~7. The sensor system of claim 5, wherein the control system is associated with~~

a security system for the space~~.~~,

~~8. The sensor system of claim 5, wherein the control system is associated with~~

a lighting system for the space~~.~~,

~~9. The sensor system of claim 5, wherein the control system is associated with~~ a power system for the space~~.~~, and

~~10. The sensor system of claim 5, wherein the control system is associated with~~ an entertainment system for the space.

~~11.~~6. The sensor system of claim 1, wherein the radio signals comprise one or more subcarriers, and wherein the at least one processor: (i) analyzes amplitude information associated with the one or more subcarriers, and (ii) determines the occupancy in the space based on the amplitude information.

~~12.~~7. The sensor system of claim 1, wherein the radio signals comprise one or more subcarriers, and wherein the at least one processor: (i) analyzes standard deviations of amplitude and phase signals associated with the one or more subcarriers, and (ii) determines occupancy in the space based on the standard deviations of amplitude and phase signals.

~~13~~8.. The sensor system of claim 1, wherein the radio signals comprise one or more subcarriers, and wherein the at least one processor: (i) analyzes temporal and frequency correlations of amplitude and phase signals associated with the one or more subcarriers, and (ii) determines occupancy in the space based on the temporal and frequency correlations of amplitude and phase signals.

~~14.~~9. The sensor system of claim 1, wherein the radio signals comprise one or more subcarriers, and wherein the at least one processor: (i) analyzes averages of amplitude and phase signals associated with the one or more subcarriers, and (ii) determines occupancy in the space based on the averages of amplitude and phase signals.

~~15.~~10. The sensor system of claim 1, wherein the radio signals comprise one or more subcarriers, and wherein the at least one processor: (i) analyzes energy in the peaks of CSI amplitude and phase signals associated with the one or more subcarriers, and (ii) determines occupancy in the space based on the energy in the peaks of CSI amplitude and phase signals.

~~16.~~11. The sensor system of claim 1, wherein the occupancy-centric algorithm is

configured to determine occupancy in the space based on changes in one or more of signal amplitude, energy, amplitude change, energy change, amplitude spread, energy spread, amplitude spread change, and energy spread change of the radio signals.

~~17.~~12. A method for determining occupancy in a space, the method comprising:

transmitting radio signals over a channel in the space;

receiving the transmitted radio signals that have traveled through the space; and

implementing an occupancy-centric algorithm with at least one processor that determines occupancy in the space based on the radio signals, that determines channel state information based on the radio signals transmitted over the channel, that determines occupancy in the space based on the channel state information, and that outputs an occupancy signal based on the determined occupancy.

~~18.~~13. The method of claim ~~17~~ 12, wherein the at least one processor is integrated with:

the receiver radio device that receives the transmitted radio signals that have traveled through the space~~.~~, or

~~19. The method of claim 17, wherein the at least one processor is integrated with~~ the transmitter radio device that transmitted radio signals over the channel in the space.

~~20. The method of claim 17 further comprising outputting a control signal to a control system with the at least one processor, wherein the control system is associated with a heating, ventilating, and cooling system for the space.~~

~~21. The method of claim 17 further comprising outputting a control signal to a control system with the at least one processor, wherein the control system is associated with a security system for the space.~~

~~22. The method of claim 17 further comprising outputting a control signal to a control system with the at least one processor, wherein the control system is associated with a lighting system for the space.~~

~~23. The method of claim 17 further comprising outputting a control signal to a control system with the at least one processor, wherein the control system is associated with a power system for the space.~~

~~24. The method of claim 17 further comprising outputting a control signal to a control system with the at least one processor, wherein the control system is associated with an entertainment system for the space.~~

~~25.~~14. The method of claim ~~17~~ 12, wherein the radio signals comprise one or more subcarriers, and wherein the at least one processor: (i) analyzes amplitude information associated with the one or more subcarriers, and (ii) determines the occupancy in the space based on the amplitude information.

~~26. The method of claim 17, wherein the radio signals comprise one or more subcarriers, and wherein the at least one processor: (i) analyzes standard deviations of amplitude and phase signals associated with the one or more subcarriers, and (ii) determines occupancy in the space based on the standard deviations of amplitude and phase signals.~~

~~27. The method of claim 17, wherein the radio signals comprise one or more subcarriers, and wherein the at least one processor: (i) analyzes temporal and frequency correlations of amplitude and phase signals associated with the one or more subcarriers, and (ii) determines occupancy in the space based on the temporal and frequency correlations of amplitude and phase signals.~~

~~28. The method of claim 17, wherein the radio signals comprise one or more subcarriers, and wherein the at least one processor: (i) analyzes averages of amplitude and phase signals associated with the one or more subcarriers, and (ii) determines occupancy in the space based on the averages of amplitude and phase signals.~~

~~29. The method of claim 17, wherein the radio signals comprise one or more subcarriers, and wherein the at least one processor: (i) analyzes energy in the peaks of CSI amplitude and phase signals associated with the one or more subcarriers, and (ii) determines occupancy in the space based on the energy in the peaks of CSI amplitude and phase signals.~~

~~30.~~15. The method of claim ~~17~~ 12, wherein the occupancy-centric algorithm is configured to determine occupancy in the space based on changes in one or more of signal amplitude, energy, amplitude change, energy change, amplitude spread, energy spread, amplitude spread change, and energy spread change of the radio signals.

~~31. A sensor system for determining occupancy in a space, comprising:~~

a transmitter radio device that transmits radio signals over a channel in the space;

a receiver radio device that receives the transmitted radio signals that have traveled through the space; and

at least one processor implementing an occupancy-centric algorithm that determines occupancy in the space based on the radio signals, wherein the at least one processor:

determines channel state information based on the radio signals transmitted over the channel,

determines occupancy in the space based on the channel state information,

determines a value chain recommendation based on the occupancy in the space of a value chain network, and

outputs an occupancy signal based on the determined occupancy and the value chain recommendation.

32. The sensor system of claim 31, wherein the value chain recommendation relates to a health of one or more workers.

33. The sensor system of claim 31, wherein the value chain recommendation relates to allocation or reallocation of worker resources based on the occupancy in the space.

34. The sensor system of claim 31, wherein the value chain recommendation is based on productivity of workers in the space.

35. The sensor system of claim 31, wherein the value chain recommendation is associated with at least one of an activation or deactivation of at least one of a heating system, a ventilating system, a cooling system, a security system, a lighting system, a kitchen system, a speaker system, a power system, and an entertainment system for the space.

36. The sensor system of claim 31, wherein the occupancy-centric algorithm evolves such that the value chain recommendation is redetermined based on the evolution of the occupancy-centric algorithm.

37. The sensor system of claim 31, wherein the value chain recommendation is determined based on a machine learning system that trains machine-learned models that output logistics design recommendations based on training data sets that each respectively defines one or more features of a respective logistic system and an outcome relating to the respective logistics system.

38. The sensor system of claim 31, wherein the value chain recommendation is determined based on an artificial intelligence system that receives a request for a logistics system design recommendation and determines the logistics system design recommendation based on one or more machine-learned models and the request.

39. The sensor system of claim 31, wherein the value chain recommendation is determined by a digital twin system that generates an environment digital twin of a logistics environment that incorporates a logistics system design recommendation, and one or more physical asset digital twins of physical assets, wherein the digital twin system executes a simulation based on the logistics environment digital twin, the one or more physical asset digital twins.

40. The sensor system of claim 31, wherein the value chain recommendation is based on logistics factors that include one or more of: a type of product corresponding to the proposed logistics solution, one or more features of the type of product, a location of a manufacturing site, a location of a distribution facility, a location of a warehouse, a location of a customer base, proposed expansion areas of the organization, and supply chain features.

41. The sensor system of claim 31, wherein the value chain recommendation is based on logistics value chain network entities that are selected from the group consisting of products, suppliers, producers, manufacturers, retailers, businesses, owners, operators, operating facilities, customers, consumers, workers, mobile devices, wearable devices, distributors, resellers, supply chain infrastructure facilities, supply chain processes, logistics processes, reverse logistics processes, demand prediction processes, demand management processes, demand aggregation processes, machines, ships, barges, warehouses, maritime ports, airports, airways, waterways, roadways, railways, bridges, tunnels, online retailers, ecommerce sites, demand factors, supply factors, delivery systems, floating assets, points of origin, points of destination, points of storage, points of use, networks, information technology systems, software platforms, distribution centers, fulfillment centers, containers, container handling facilities, customs, export control, border control, drones, robots, autonomous vehicles, hauling facilities, drones/robots/AVs, waterways, and port infrastructure facilities.

42. The sensor system of claim 41, wherein the supply chain infrastructure facilities are facilities selected from the group consisting of ship, container ship, boat,

barge, maritime port, crane, container, container handling, shipyard, maritime dock, warehouse, distribution, fulfillment, fueling, refueling, nuclear refueling, waste removal, food supply, beverage supply, drone, robot, autonomous vehicle, aircraft, automotive, truck, train, lift, forklift, hauling facilities, conveyor, loading dock, waterway, bridge, tunnel, airport, depot, vehicle station, train station, weigh station, inspection, roadway, railway, highway, customs house, and border control facilities.

43. The sensor system of claim 31, wherein the value chain recommendation is based on supply factors that are selected from the group consisting of Component availability, material availability, component location, material location, component pricing, material pricing, taxation, tariff, impost, duty, import regulation, export regulation, border control, trade regulation, customs, navigation, traffic, congestion, vehicle capacity, ship capacity, container capacity, package capacity, vehicle availability, ship availability, container availability, package availability, vehicle location, ship location, container location, port location, port availability, port capacity, storage availability, storage capacity, warehouse availability, warehouse capacity, fulfillment center location, fulfillment center availability, fulfillment center capacity, asset owner identity, system compatibility, worker availability, worker competency, worker location, goods pricing, fuel pricing, energy pricing, route availability, route distance, route cost, and route safety factors.

44. The sensor system of claim 31, wherein the value chain recommendation is determined based on a machine learning/artificial intelligence system determining a problem state based on a detected stress level of humans along a supply chain.

45. The sensor system of claim 31, wherein the value chain recommendation is determined based on disruptions in the space of the value chain network.

46. The sensor system of claim 31, wherein the value chain recommendation includes operating recommendations needed to compensate for changes in operating parameters.

47. The sensor system of claim 31, wherein the value chain recommendation is determined from physical activities data and worker data in order to improve value chain workflows.

48. The sensor system of claim 31, wherein the value chain recommendation includes suggestions for removing or limiting worker redundancies for a

~~workflow.~~

~~49. A method for determining occupancy in a space, the method comprising:~~

~~transmitting radio signals over a channel in the space;~~

~~receiving the transmitted radio signals that have traveled through the space; and~~

~~implementing with at least one processor an occupancy-centric algorithm that determines occupancy in the space based on the radio signals, that determines channel state information based on the radio signals transmitted over the channel, that determines occupancy in the space based on the channel state information, that determines a value chain recommendation based on the occupancy in the space of a value chain network, and that outputs an occupancy signal based on the determined occupancy and the value chain recommendation.~~

~~50. The method of claim 49, wherein the value chain recommendation relates to a health of one or more workers.~~

~~51. The method of claim 49, wherein the value chain recommendation relates to allocation or reallocation of worker resources based on the occupancy in the space.~~

~~52. The method of claim 49, wherein the value chain recommendation is based on productivity of workers in the space.~~

~~53. The method of claim 49, wherein the value chain recommendation is associated with at least one of an activation or deactivation of at least one of a heating system, a ventilating system, a cooling system, a security system, a lighting system, a kitchen system, a speaker system, a power system, and an entertainment system for the space.~~

~~54. The method of claim 49, wherein the occupancy-centric algorithm evolves such that the value chain recommendation is redetermined based on the evolution of the occupancy-centric algorithm.~~

~~55. The method of claim 49, wherein the value chain recommendation is determined based on a machine learning system that trains machine-learned models that output logistics design recommendations based on training data sets that each respectively defines one or more features of a respective logistic system and an outcome relating to the respective logistics system.~~

~~56. The method of claim 49, wherein the value chain recommendation is determined based on an artificial intelligence system that receives a request for~~

a logistics system design recommendation and determines the logistics system design recommendation based on one or more machine-learned models and the request.

57. The method of claim 49, wherein the value chain recommendation is determined by a digital twin system that generates an environment digital twin of a logistics environment that incorporates a logistics system design recommendation, and one or more physical asset digital twins of physical assets, wherein the digital twin system executes a simulation based on the logistics environment digital twin, the one or more physical asset digital twins.

58. The method of claim 49, wherein the value chain recommendation is based on logistics factors that include one or more of: a type of product corresponding to the proposed logistics solution, one or more features of the type of product, a location of a manufacturing site, a location of a distribution facility, a location of a warehouse, a location of a customer base, proposed expansion areas of the organization, and supply chain features.

59. The method of claim 49, wherein the value chain recommendation is based on logistics value chain network entities that are selected from the group consisting of products, suppliers, producers, manufacturers, retailers, businesses, owners, operators, operating facilities, customers, consumers, workers, mobile devices, wearable devices, distributors, resellers, supply chain infrastructure facilities, supply chain processes, logistics processes, reverse logistics processes, demand prediction processes, demand management processes, demand aggregation processes, machines, ships, barges, warehouses, maritime ports, airports, airways, waterways, roadways, railways, bridges, tunnels, online retailers, ecommerce sites, demand factors, supply factors, delivery systems, floating assets, points of origin, points of destination, points of storage, points of use, networks, information technology systems, software platforms, distribution centers, fulfillment centers, containers, container handling facilities, customs, export control, border control, drones, robots, autonomous vehicles, hauling facilities, drones/robots/AVs, waterways, and port infrastructure facilities.

60. The sensor system of claim 59, wherein the supply chain infrastructure facilities are facilities selected from the group consisting of ship, container ship, boat, barge, maritime port, crane, container, container handling, shipyard, maritime dock, warehouse, distribution, fulfillment, fueling, refueling, nuclear refueling,

~~waste removal, food supply, beverage supply, drone, robot, autonomous vehicle, aircraft, automotive, truck, train, lift, forklift, hauling facilities, conveyor, loading dock, waterway, bridge, tunnel, airport, depot, vehicle station, train station, weigh station, inspection, roadway, railway, highway, customs house, and border control facilities.~~

~~61. The method of claim 49, wherein the value chain recommendation is based on supply factors that are selected from the group consisting of Component availability, material availability, component location, material location, component pricing, material pricing, taxation, tariff, impost, duty, import regulation, export regulation, border control, trade regulation, customs, navigation, traffic, congestion, vehicle capacity, ship capacity, container capacity, package capacity, vehicle availability, ship availability, container availability, package availability, vehicle location, ship location, container location, port location, port availability, port capacity, storage availability, storage capacity, warehouse availability, warehouse capacity, fulfillment center location, fulfillment center availability, fulfillment center capacity, asset owner identity, system compatibility, worker availability, worker competency, worker location, goods pricing, fuel pricing, energy pricing, route availability, route distance, route cost, and route safety factors.~~

~~62. The method of claim 49, wherein the value chain recommendation is determined based on a machine learning/artificial intelligence system determining a problem state based on a detected stress level of humans along a supply chain.~~

~~63. The method of claim 49, wherein the value chain recommendation is determined based on disruptions in the space of the value chain network.~~

~~64. The method of claim 49, wherein the value chain recommendation includes operating recommendations needed to compensate for changes in operating parameters.~~

~~65. The method of claim 49, wherein the value chain recommendation is determined from physical activities data and worker data in order to improve value chain workflows.~~

~~66. The sensor system of claim 49, wherein the value chain recommendation includes suggestions for removing or limiting worker redundancies for a workflow.~~